Welcome to the *Climate-Safe Infrastructure* Webinar Series

Supporting AB2800 and the Work of California's Climate-Safe Infrastructure Working Group

May 29, 2018 | 12-1pm

CALIFORNIA natural resources AGENCY

Hosts

Juliette Finzi Hart | USGS

Co-Facilitator of CSIWG's work

Email: jfinzihart@usgs.gov

Susi Moser | Susanne Moser Research & Consulting

Co-Facilitator of CSIWG's work

Email: promundi@susannemoser.com

AB 2800 (Quirk): Purpose

Examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering, including oversight, investment, design, and construction.

AB2800 Working Group and Support Team

Co-Facilitators

Juliette Finzi Hart
USGS

Susi Moser
Susanne Moser
Research & Consulting

The Climate-Safe Infrastructure Working Group

Amir Aghakouchak
UC-Irvine

Bruce Swanger
Cal-Trans

Chester Widom
DGS, State Architect

Cis Liban
L.A. Metro

Dan Cayan
UC-San Diego, SIO

David Groves
RAND

Nancy Ander
DGS, Off. of Sustain.

Deb Niemeier
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James Deane
High-Speed Rail Auth.

John Andrew
DWR

Kristin Heinemeier
Realized Energy

Kyle Meng
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Noah Diffenbaugh
Stanford

Gurdeep Bhattal
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Robert Lempert
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Project Team

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Joey Wall
Natural Resources
Agency

Guido Franco
California Energy
Commission

AB 2800 (Quirk):
Scope of Assessment and Recommendations





The working group shall consider and investigate, at a minimum, the following issues:

(1) **informational and institutional barriers** to integrating climate change into infrastructure design.

(2) **critical information needs** of engineers.

(3) **selection of appropriate engineering designs** for different climate scenarios.

The *Climate-Safe Infrastructure* Webinar Series

Purpose

- Hear from others elsewhere with relevant experience and expertise.
- Hear from CSIWG members.
- Educate and engage with interested stakeholders on climate change and infrastructure issues.

Sample of Webinar Topics

- What climate science can offer
- Various sectoral perspectives
- Processes of changing engineering standards and guidelines
- Holistic infrastructure planning and management
- Financing climate-safe infrastructure
- And others…

A Couple of Housekeeping Items

- Please type your questions for presenters into the chat box
- We will try to answer as many as possible after the presentations
- Answers to remaining questions will be posted on the website
- Thank you to USC Sea Grant!

Today's Webinar:

Financing Climate-Safe Infrastructure II

John Cleveland
Boston Green Ribbon Commission
Innovation Network for Communities

Vladimir Antikarov
The Verea Group

Karl Schultz
High Ground Foundation

Urban Adaptation Finance Systems

California Climate Safe Infrastructure Working Group Webinar
May 29, 2018

John Cleveland, President
Innovation Network for Communities

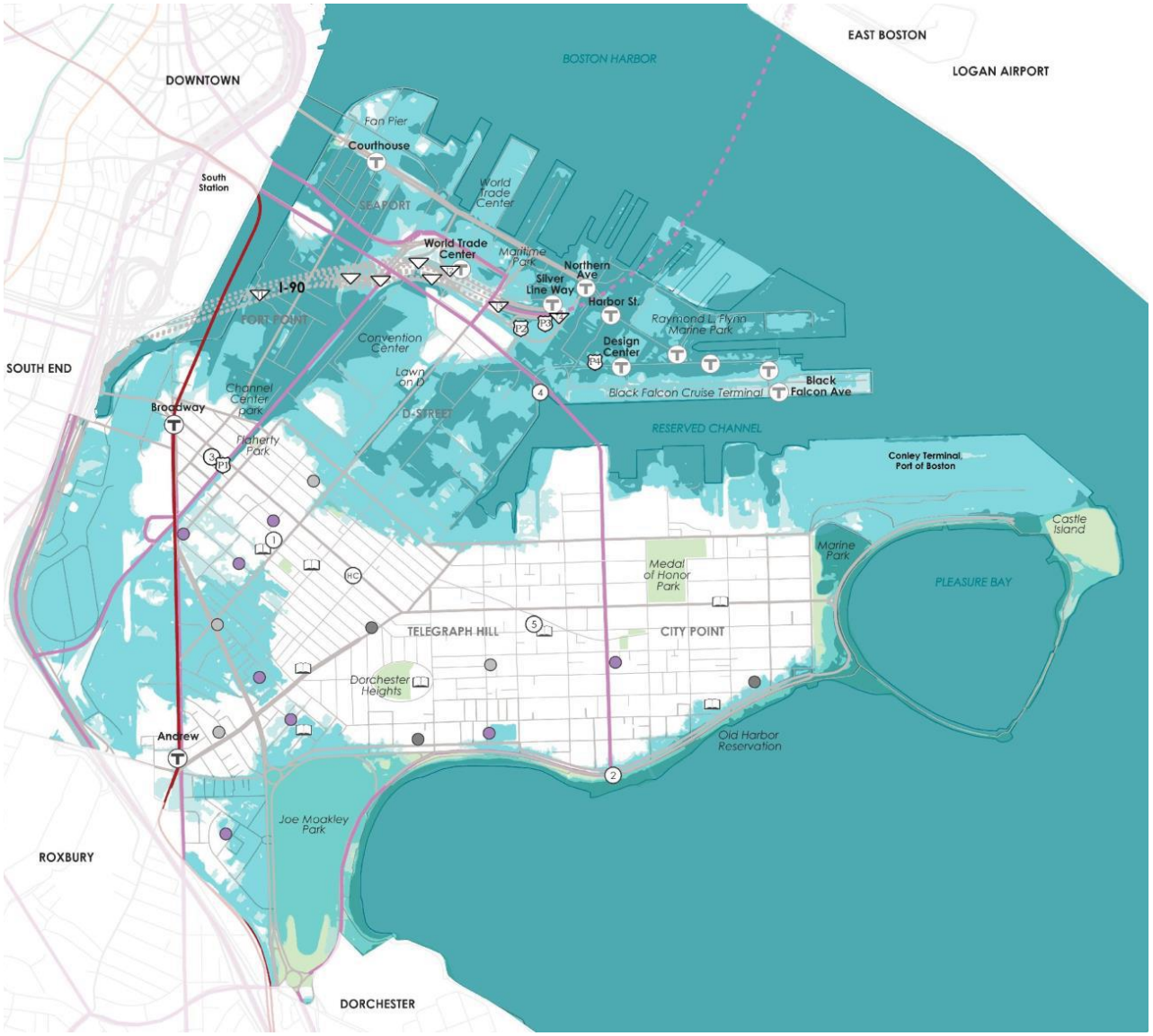
Overview

- **Climate risks impose new costs on many cities that are not currently accounted for in their financing systems.**
- **We know how to develop complex urban financing systems – we have done it already for many areas of public responsibility.**
- **In climate adaptation there are many interesting experiments and innovations underway, but they don't come close to constituting a "system".**
- **A "system" standardizes complex transactions so they can be predictably executed on a routine basis.**
- **An urban adaptation financing system is far more than a set of financing "tools".**

Downtown Boston Flooding Circa 2100

Source: Climate Ready Boston (https://www.boston.gov/departments/environment/climate-ready-boston)

Seaport District Flooding Circa 2100



Source: Climate Ready Boston (https://www.boston.gov/departments/environment/climate-ready-boston)

Unanswered Questions to the $4 Billion Challenge

- ***Whose responsibility is it to design, build, manage and maintain resilience investments?***
- ***How will the projects be funded (source of revenue) and financed (deal structure)?***
- ***How will costs be distributed across different property owners and different levels of government?***
- ***How will cost-benefit analysis be calculated?***
- ***To what standard of risk should the projects be designed?***
- ***What standard of risk management should we impose on existing infrastructure investments, and how?***

It Takes A “System”

Data And Analytics

- Climate risk forecasts
- Vulnerability assessments

Project Pipeline

- Planning process
- Standards for prioritizing
- Project management flow

Governance Structures

- District & municipal scale
- Regional & State scale

Financing Tools

- Funding (revenue source)
  - *Taxes, fees, grants, private $*
- Financing (deal structure)
  - *Debt, pay as you go, risk hedging*

INTEGRATION ACROSS SCALES:

- **District**
- **Municipal**
- **Regional**
- **State**
- **Private Markets**

We Know How to Do This

MBTA Capital Investment Program

- 16 blended funding sources
- $7.4 billion 5-year total
- All the system elements are in place and standardized
- Nobody freaks out when we need to fund a project!

Projected sources (in millions)	Final FY 18	Final 5 year Total
Federal sources of funds		
Federal Highway (FHWA) reimbursements	$67.4	$157.1
Federal Transit (FTA) reimbursements (prospective)	$106.4	$1,798.6
Existing FTA reimbursements and grant draws	$168.6	$652.0
FTA Full funding grant agreement (GLX FFGA)	$62.6	$996.1
Other federal funds	$1.3	$4.2
Positive Train Control (PTC) loans	$78.2	$365.0
Subtotal federal sources	**$484.5**	**$3,973.0**
Bond cap	$0.8	$1.2
Accelerated Bridge bonds	$6.4	$10.4
Rail enhancement bonds	$151.5	$1,238.6
Revenue bonds	$135.1	$1,338.7
Metropolitan Highway system (MHS) pay-go	$1.1	$2.4
Gaming funds	$2.3	$2.3
Municipal and local funds (GLX)	$0.0	$75.0
Reimbursable and 3rd parties	$5.0	$8.4
Additional State Assistance*	$150.0	$750.0
Capital maintenance fund	$5.4	$9.5
Subtotal of non federal sources	**$457.6**	**$3,436.6**
Total Sources	**$942.1**	**$7,409.6**

Challenges To Building the System

- **Most projects don’t generate revenue**
- **Many cities are at their general fund borrowing limits**
- **Many market and government mechanisms inaccurately price risk**
- **Risk prediction still has many uncertainties**
- **Structures don’t exist to manage projects across municipal boundaries**

Collaboration Can Accelerate Innovation

Thank You!

John Cleveland, President
Innovation Network for Communities
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Dealing with Climate Change through Optimal Resilience and Adaptation: The Real Options Approach

Vlad Antikarov

Verea Group LLC

Executive Summary

- Infrastructure projects are usually some of the most expensive items in government and private companies' budgets. As the benefits of infrastructure spread over decades but the costs of building it are required now, such projects already have a hard time competing with more immediate priorities.

- In recent years, there has been growing awareness of climate change and the additional demands it poses on the needed resilience and adaptability of infrastructure projects.

- As the speed and severity of climate change are uncertain, different constituencies are engaged in endless arguments about which particular scenario will eventually unfold.

- Because of this uncertainty, it has become even harder to secure funding for the resilience and adaptation component of Infrastructure projects.

Real Option Analysis is an innovative cost benefit methodology which allows us to correctly evaluate the benefits of climate change mitigation and adaptation investments and consequently to justify the necessary funding.

HM Treasury Recommendation to Use Real Option Analysis for Evaluating Policies, Programs and Projects

Accounting for the Effects of Climate Change

June 2009

Supplementary Green Book Guidance

HM TREASURY

defra
Department for Environment Food and Rural Affairs

3. Appraising and Evaluating Policies, Programmes and Projects

3.1 Appraising Options

The standard Green Book approach to option appraisal should be followed for adaptation measures, giving consideration to section 3.1.5 on specific issues. If an activity has uncertainty, flexibility and learning potential, a Real Options approach may be appropriate.

3.1.1 Using Real Options Analysis

The initial risk assessment (section 2.1.2) should examine the suitability of a Real Options approach. Consider the sensitivity to uncertainty, the potential for learning, and the degree of flexibility.

Flexibility to respond to new information can be valuable. However, waiting for new information should not be used to justify delaying action. Decisions should be taken with the best available information, recognising that this may change in the future.

3.1.2 Using Real Options Analysis qualitatively

A decision tree can be used to map out and understand the sequence of actions, decision points and events along an activity's path[5]. It is not a substitute for quantified appraisal. It should consider the range of options available (now and in the future), how information is likely to be acquired, and should incorporate monitoring and evaluation of progress (see section 3.2).

3.1.3 Real Options Analysis as a quantitative tool

A quantitative Real Options appraisal follows the same principles as a Green Book cost-benefit analysis. Streams of costs and benefits should be compared over time and discounted to generate a Net Present Value (NPV). The additional step in a Real Options appraisal is to account for the value of flexibility in the structure of the activity.

Assessing options quantitatively should build on qualitative analysis. The decision tree can be populated with information on costs, benefits, and probabilities associated with different options. Sensitivity analysis

[5] See Chapter 5 of the Green Book.

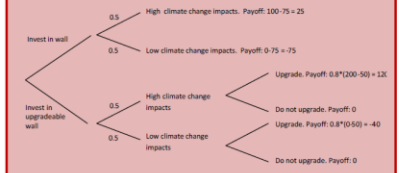
can be used to examine the implications of alternative climate change scenarios.

Box 6 outlines how a Real Options approach, using a decision tree, could be used to calculate the NPV of a proposal. It shows that valuing flexibility and the potential for learning from new information can give a different outcome. With sufficient flexibility, the option to stop the investment if it turns out not to be worthwhile has inherent value, and this is reflected in the NPVs.

Box 6: Appraisal using a Real Options approach

Consider a proposal for investing in infrastructure protecting against the impacts of flooding due to climate change. There are two options: invest in a wall, or invest in a wall which has the option to upgrade in the future. There is an equal probability of high or low climate change impacts in the future. The standard wall costs 75, and has benefits of 100 from avoided flooding. The upgradeable wall costs 50, the upgrade costs 50 and would give benefits of 200 from avoided flooding.

The information can be set out in a decision tree:



Simplifying assumptions: residual damages under the "do not invest" strategies have been ignored; the discount factor is 0.8.

The expected value of investing in the standard wall is a simple NPV calculation, calculating the expected costs and benefits of the investment. The NPV is (0.5*25) + (0.5*-75) = -25. This suggests the investment should not proceed.

Flexibility over the investment decision allows the possibility to upgrade in the future if the impacts of climate change are high. The expected value of this option can be calculated.

If the impacts of climate change are high enough to warrant upgrading, then the value of the investment is 120. If the impacts are low, then upgrading is not justified since the payoff is negative (-40). Since the investment costs of the upgrade are not realised in practice in the low outcome, they are therefore not incorporated into the NPV. The expected value of investing now with the option to upgrade in the future is (0.5*120) – 50 = +10.

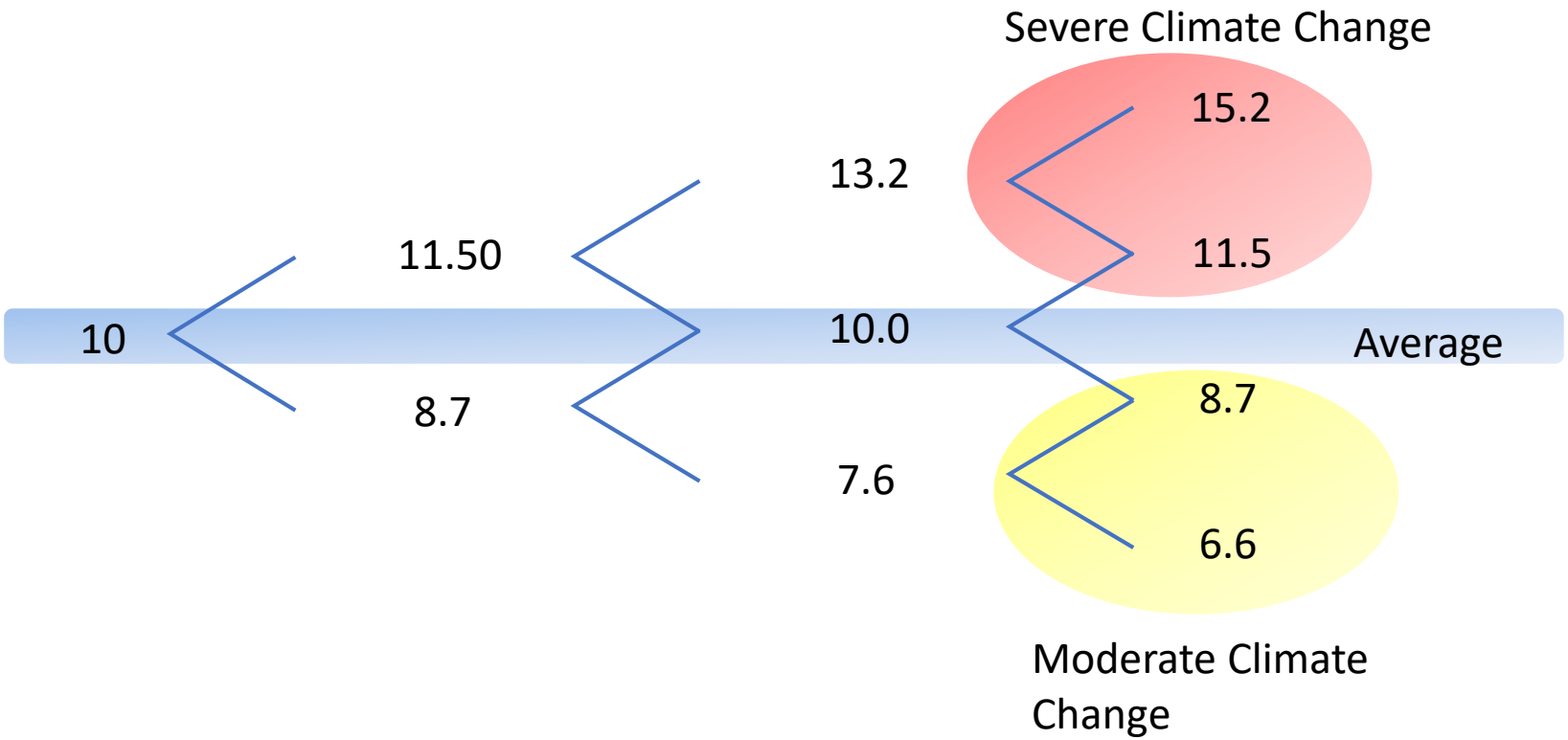
Comparing the two approaches shows an NPV of -25 for the standard approach, and +10 for the Real Options approach. Flexibility to upgrade in the future is reflected in the higher NPV, and switches the investment decision.

Stylized Example of Optimal Adaptation with an Infrastructure Project

- A coastal community is experiencing the increasing impact of climate change expressed in intensifying beach erosion and more frequent flooding.
- The infrastructure project can remedy those negative impacts and so provide significant economic, social, and environmental benefits. However, the required investments is very significant and is difficult to justify.
- Part of the problem is that the future trend in climate change impact is not certain. There is a significant range of scenarios that can unfold in the future and under which the value provided by the mitigation project would be very different.
- Unfortunately, the traditional NPV evaluation approach values projects in the "all or nothing“ and "now or never" manner.
- If the project can be modularized and the timing of its execution made flexible and dependent on the actual climate change impact scenario, it's economics and investment attractiveness could change dramatic.

Uncertainty of Sea Level Rising - New York City

- Sea level rise in New York City has averaged 1.2 inches per decade (total of 1.1 feet) since1900, nearly twice the observed global rate of 0.5 to 0.7 inches per decade over a similar time period.
- Sea level rise in New York City is projected to continue to exceed the global average. Sea level rise is very likely to accelerate as the century progresses. Projections for sea level rise in New York City are 11 to 21 inches by the 2050s, 18 to 39 inches by the 2080s, and could reach as high as 6 feet by 2100.



Project Parameters and NPV Valuation

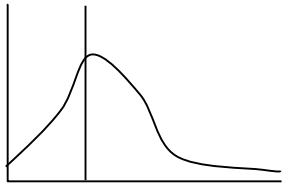
The mitigation project can be implemented as two separate, but sequential modules.

- The current Avoided damages, if implemented immediately, is $1000 assuming the average 10 inches increase
- The first module would requires an investment of $400
- The second module build on the first and would requires investment of $800.
- Cost of capital accounting for risk – 9%

PV = 772

NPV = 772 – 400-618

NPV = - 246



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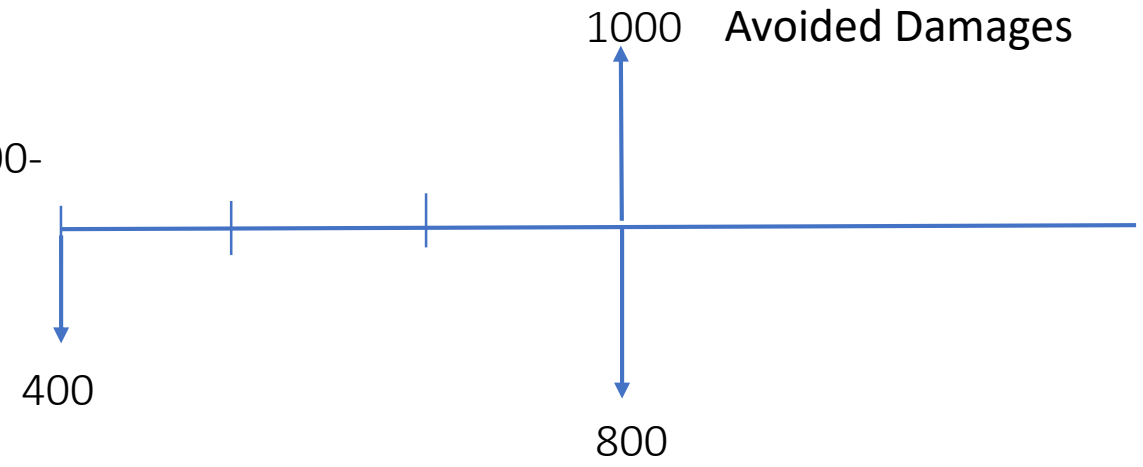
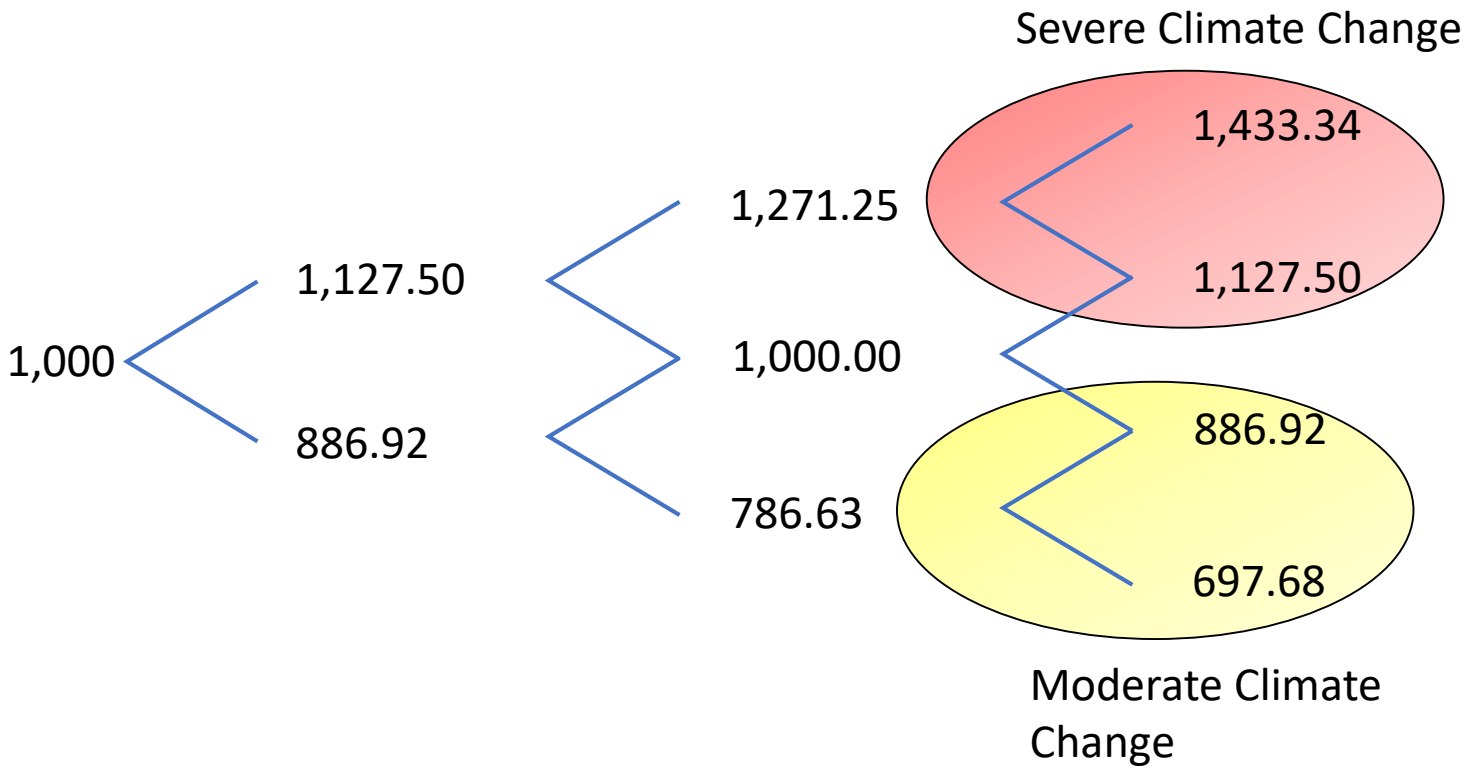


Uncertainty of Climate Change Impact and the Value of the Project

- We can represent the uncertainty of the climate change impact in the future as uncertainty of the value of the project for the region as a cone of scenarios:

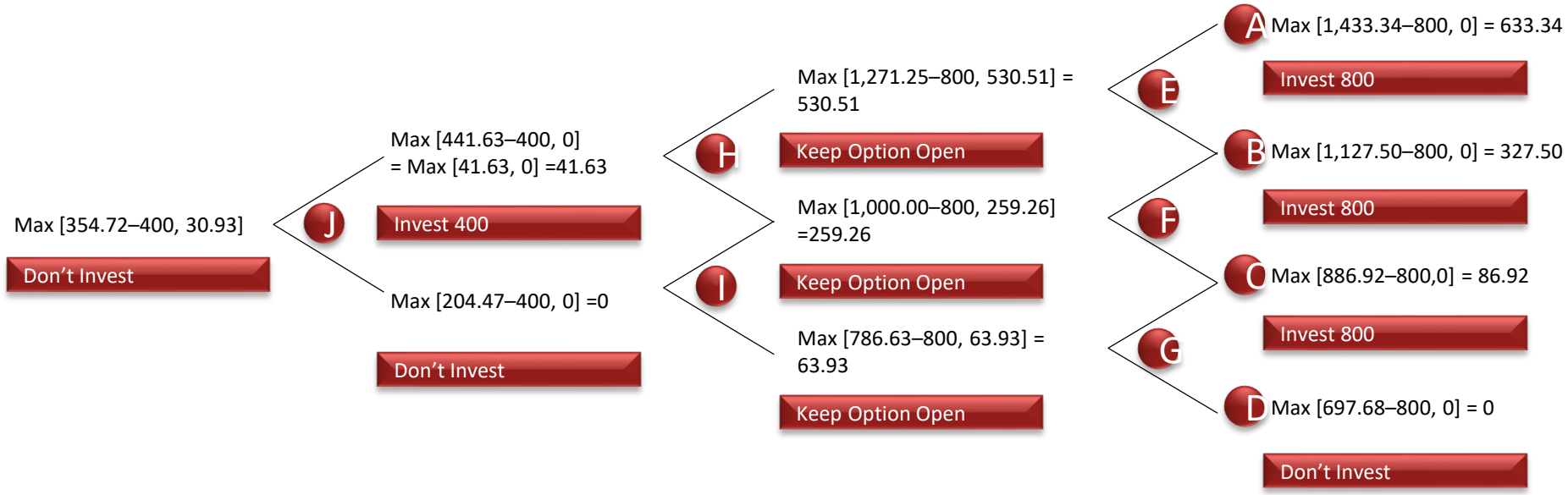
  - If the climate change impacts become more severe, the value of the project will increase
  - If the climate change impacts taper off, the value of the project will significantly decrease



Identifying Optimal Execution under Different Likely Scenarios

- Because of the uncertainty regarding the value of the project, flexibility around its implementation is valuable:
  - Building the first module can be represented as an option that can be executed immediately or a year later
  - Building the second module can be represented as an option that can be executed in year three or four, if the first module is already built

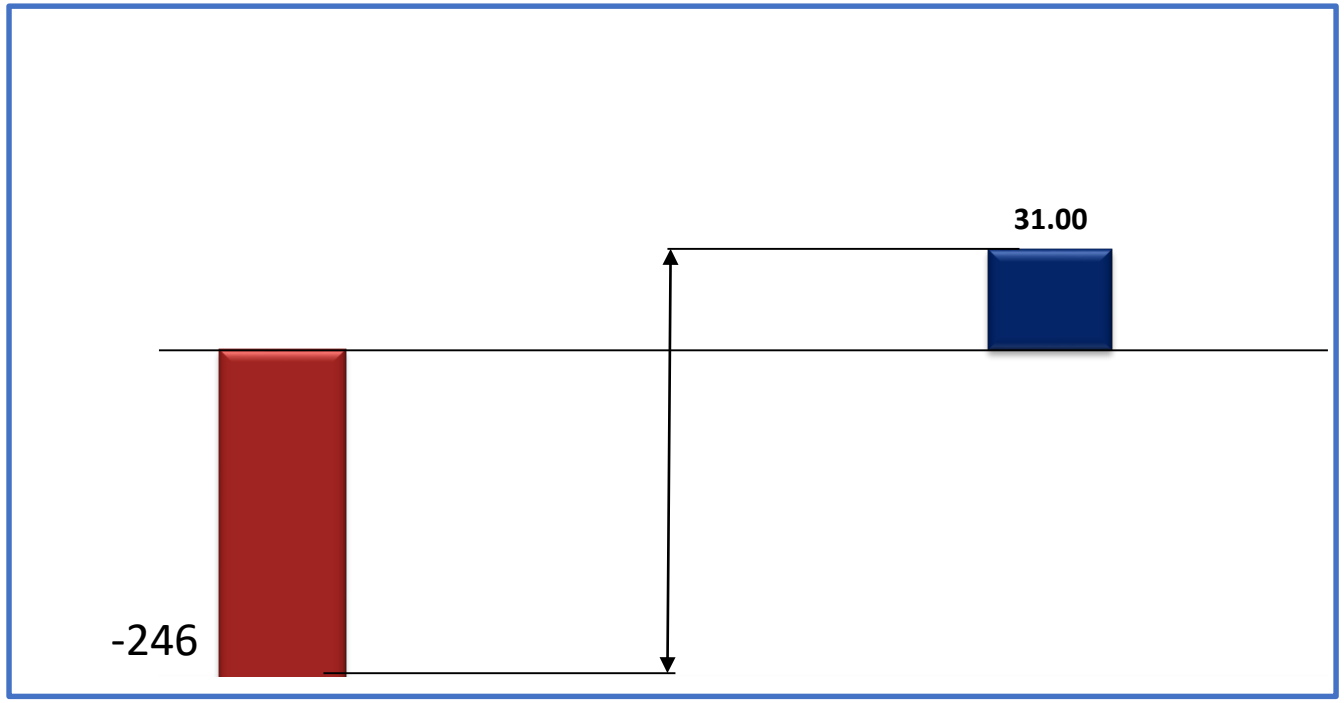
- ROA identifies the optimal implementation of the project under each likely scenario



Valuing Flexibility of Execution

- Because of the significant uncertainty of climate change impact, flexibility in executing the project is very valuable and is captured by Real Options Analysis (ROA)

- As can be seen, the flexibility makes the project economically attractive. With ROA a project can be proved viable and kept under consideration even though its immediate implementation is not economically justified



Conclusion

- Traditional project evaluation methodologies do not properly reflect the two key characteristics of dealing with climate change -- the future uncertainty of its impacts and the required flexibility to mitigate them.

- By properly incorporating and evaluating climate change impact uncertainty and mitigation flexibility, real options analysis can become a critical tool in achieving the following key objectives:
  - Optimize project design to achieve long-term resilience and adaptability at minimum cost (including monetizing of options)
  - Broader and longer-lasting mitigation impact with limited available funding
  - Reflect the full value of projects while reducing their risks, and increasing their appeal for stakeholders and investors
  - Attract additional sources of funding for climate change mitigation projects.

About Us & Contact

Vladimir Antikarov is a Principal at Verea Group LLC. With over 20 years of experience, Mr. Antikarov has served as a senior member of the corporate finance practice with the Monitor Group (1992-2005), now Monitor Deloitte, and as Senior Advisor to the CFO of Overseas Shipholding Group, Inc. (2005-2012). His client engagements have included work with AT&T, Merck, Lockheed Martin, Lucent/Avaya, Thomson Reuters, Philips, Roche, Valle, Votorantim, Telefonica, Axel Johnson and World Bank.

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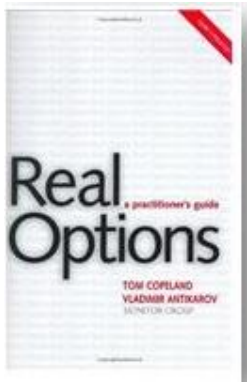


Mr. Antikarov is co-author, with Tom Copeland, of the bestselling book, Real Options, A Practitioner's Guide, used by MIT, Harvard, The Wharton School and many other business schools. The book has been published in six languages and was the number one business book on Amazon UK.

PRMIA
The Professional Risk Managers' International Association

A member of numerous professional associations, most recently Mr. Antikarov has been elected by his professional colleagues as Regional Director of the Professional Risk Manager International Association (PRMIA) for the Washington DC area.

Vulnerability Reduction Credit (VRC™) Standard Framework:
Governance and Quality Assurance Standards Underpinning Adaptation Metrics

Karl Schultz, Executive Chairman

The Higher Ground Foundation
- stand up to climate change

CSIWG webinar - Financing Infrastructure II

29 May 2018

The Higher Ground Foundation

To create a future where the best responses to climate change are the choices the world wants to make.

The Higher Ground Foundation

Diverse expertise interested in encouraging climate adaptation through a credit instrument and governance regime

REQUIRES:

Developing/applying quantitative and qualitative principles and approaches

Motivation for target setting, evaluation, and incentivizing adaptation

Testing through pilot projects in diverse, climatically vulnerable systems

The Higher Ground Foundation




Central to the aim of The Higher Ground Foundation is introducing the climate

Vulnerability Reduction Credit (VRC™)

Vulnerability Reduction Credits (VRCs™)

How VRCs are relevant?

VRCs™ enable their purchasers (e.g. governments/ private investors) knowledge of the effectiveness that the return on that investment is likely to bring to communities in terms of adapting to climate change effects.

VRCs enable sustained knowledge of the return through clear and robust registration standards, continuous monitoring and third-party verification for crediting, and periodic revisiting of the project baseline over the lifetime of the project/investment.

Vulnerability Reduction Credits (VRCs™)

How are VRCs relevant?

- VRCs can help support adaptation target setting, planning, and implementation of robust projects.

Specific Approaches

- Assess alternative technical options for different sectors
  - Able to compare across sectors and integrate systems - not just stressors

VRPM- Flood Defense

- Policies and planning
  - Targets set in VRCs: results based
  - Finance: If priced, creates a revenue stream to secure/service finance

Vulnerability Reduction Credits (VRCs™)

Using Impact Cost Analysis to Create a ”Universal” Metric

$$\text{Number of VRCs} = \frac{(\text{AIC} \times \text{IEF})}{€50}$$

Avoided Impact Cost

Nominal Value

Income Equalization Factor

Vulnerability Reduction Credits (VRCs™)

At the heart of the VRC premise:

Human vulnerability is more important than protecting assets

Economic cost/benefits can be a proxy for human vulnerability + supports avoidance of "double counting"

Loss and damage can be equalised for poorer communities by factoring in per capita income

Economic well-being
≠
human well-being

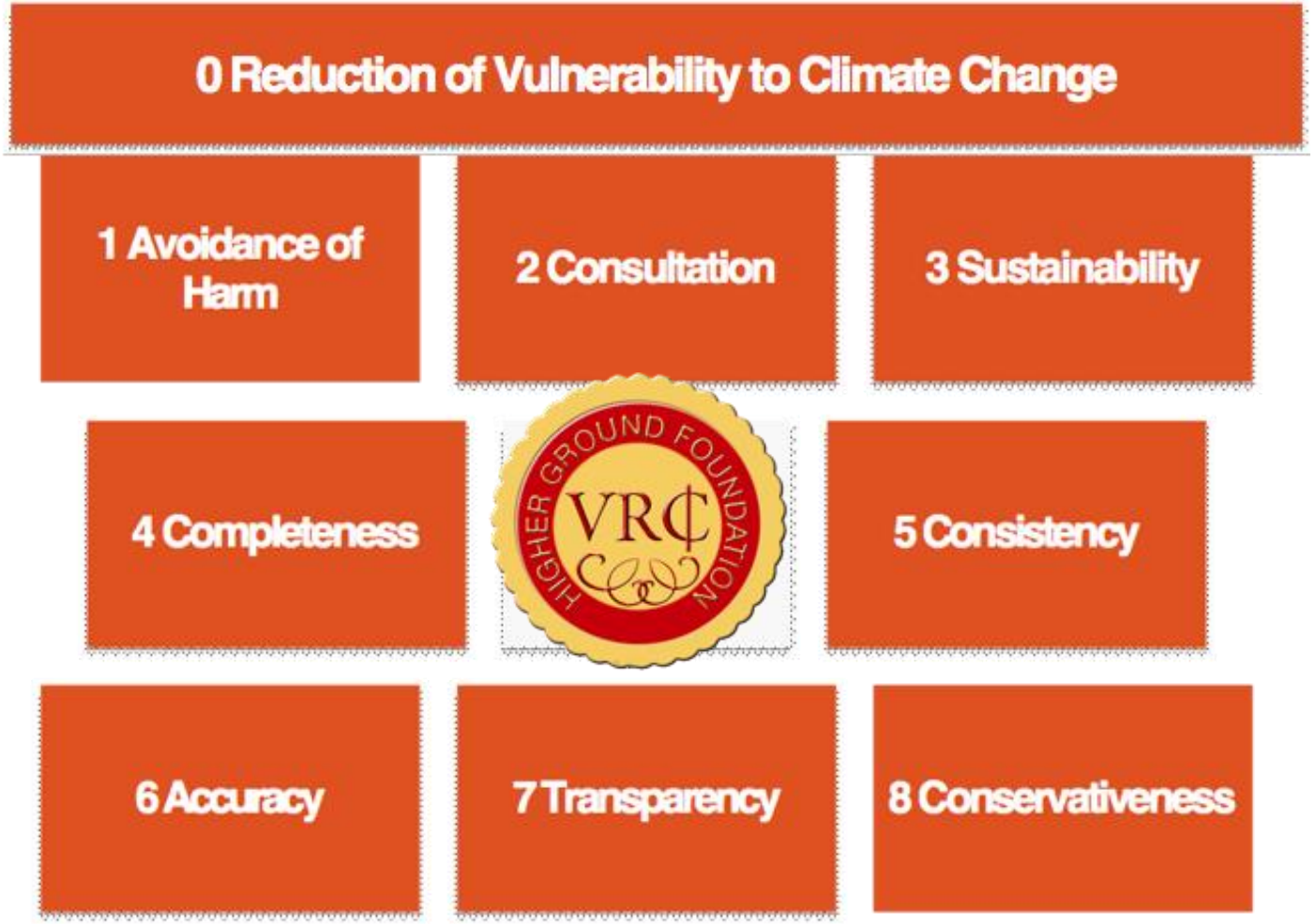
VRCs can be used in conjunction with other impact/evaluation methodologies

Beyond a Metric: VRC Standard Framework

Standard

Framework

Principles



Beyond a Metric: VRC Standard Framework

The Higher Ground Foundation
- stand up to climate change

Vulnerability Reduction Credit (VRC™) Standard Framework

V1.1 (March 2018)

1

Contents

Beyond a Metric: VRC Standard Framework

0.1 Terminology

Notes:

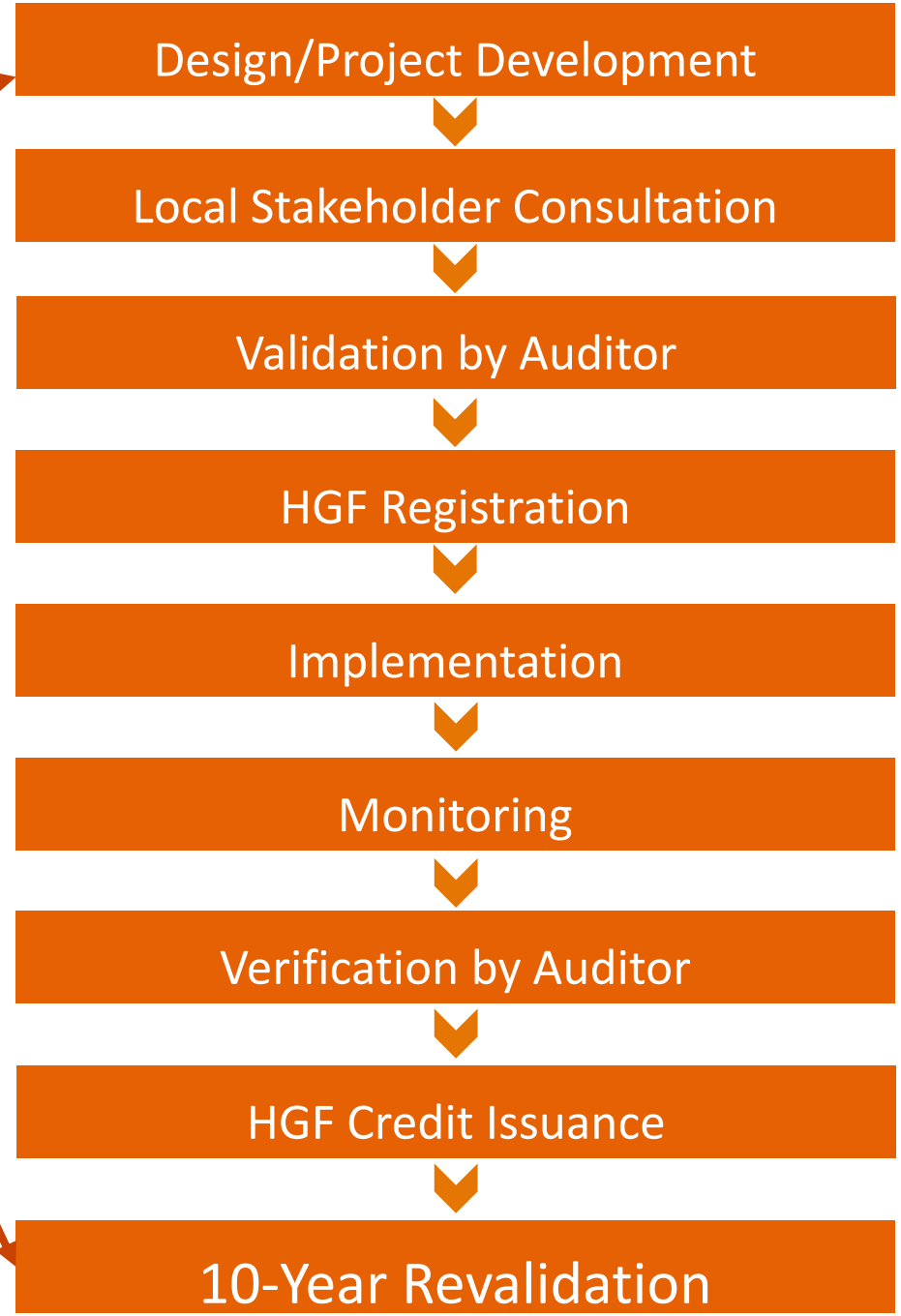
When the Framework does not define a term or acronym, the IPCC's Fifth Assessment Report, 2nd Working Group glossary may be referenced at:

http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf

If in the future the Framework is translated into other languages, the legal version shall remain with the original English language version.

HGF Approved Methodology + System and Project Details

VRC PROJECT PROCESS



4. VRCs in Action: A Case for California

Flood Damages

Forest Fires

Agricultural Losses

Coastal Erosion

Water for Communities

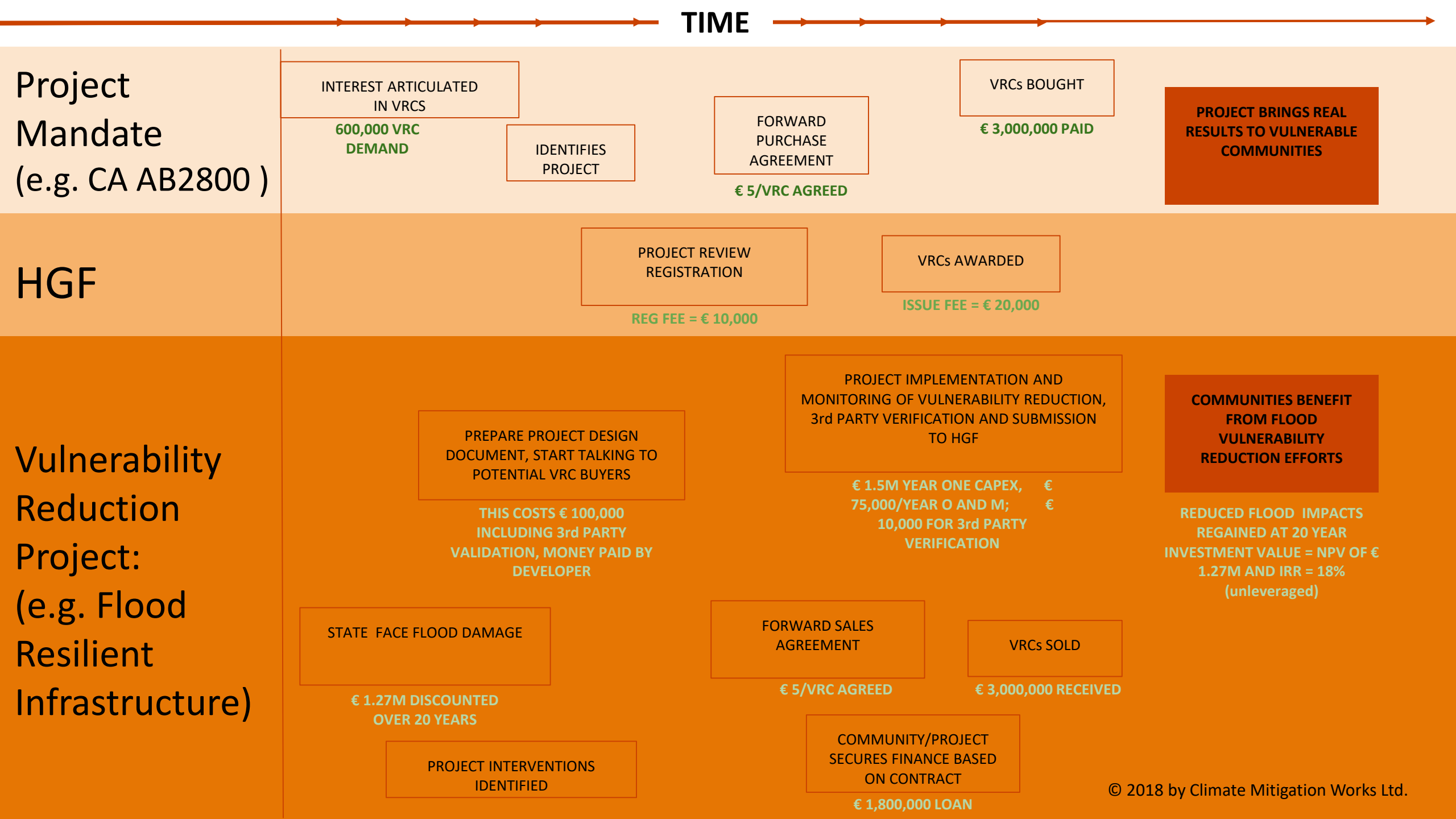
Flood Damages

Storm Loss and Damage

4. VRCs in Action: A Case for California

MAKING INFRASTRUCTURE FLOOD RESILIENT

A Project Process Example



VRCs in Action

Summary of VRCs

VRCs offer a whole-systems approach to encourage better climate adaptations with many applicable uses

The approach is underpinned by a robust Standard Framework with human vulnerability reduction at its heart

The whole span of adaptation interventions are a subject of interest, as VRCs apply where cost : benefit analysis tools apply

What's Next For Higher Ground

Next Steps for The Higher Ground Foundation

We have launched our VRC Standard Framework and Pilot Implementation and Partnerships Phase (PIPP) at COP-23 in November 2017

- We are focused on partnering with relevant institutions and experts
- We are piloting VRC approaches in different sectors with different adaptation projects

For more information and to discuss:

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The Higher Ground Foundation

- stand up to climate change

Today's Webinar:

Financing Climate-Safe Infrastructure II

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High Ground Foundation

Thank you!

- The ***Climate-Safe Infrastructure*** Webinar Series continues at least through July 2018
- Upcoming webinars:
  - Building a Climate-Safe Future for All: Social Equity and Inclusion – May 30, 2018
  - Enabling scientists and engineers working together effectively – June 4, 5 or 6
  - Tools Supporting Climate-Safe Infrastructure Design – June 8
  - Financing the Future, Part 3 – late June
  - Talking climate change with engineers – July
  - Monitoring performance – working toward success – July
- Track webinars and progress of CSIWG at: http://resources.ca.gov/climate/climate-safe-infrastructure-working-group/
- Questions: Joey Wall - Joseph.Wall@resources.ca.gov